Are transnational corporations an impediment to trade adjustment?*

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There has been a long debate over whether intra-firm trade by transnational corporations is as responsive to exchange-rate changes as arm's-length trade is. The issue is largely empirical because, in theory, the answer can go either way. The few studies that have considered this question suggest that intra-firm trade is relatively inelastic. Unfortunately, these studies leave serious doubts because they are based upon insufficient data and do not explore industry-mix issues. This article aims at shedding more light on these matters. Using the period 1985-1989, it examines the relative vigor and speed with which United States exports—intra-firm and arm's-length—responded to the dollar's sharp drop. Contrary to commonly held views, intra-firm trade responded to the dollar's drop as vigorously as arm's-length trade and even more rapidly. Accordingly, the article concludes that transnational corporations are not an impediment to trade adjustment.

There has been a long debate in the United States over whether or not transnational corporations (TNCs) are an impediment to the macroeconomic adjustment process initiated by exchange-rate changes (Bergsten *et al.*, 1978, chap. 8). The central question in this debate has been: does the intra-firm trade of TNCs respond to exchange-rate changes in the anticipated direction and with the degree of elasticity exhibited by arm's-length trade? In particular, when a home country's currency depreciates, do the intra-firm exports of its TNCs rise by as much as the country's arm's-length exports?

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The debate is important from a policy perspective because United States TNCs ship over 40 per cent of their exports to their majority-owned affiliates abroad. If aircraft manufacturers are excluded, the intra-firm figure rises to 48 per cent (United States, Department of Commerce, 1991b, table 85, columns 6 and 14). Overall, TNCs account for nearly 80 per cent of United States manufacturing exports (United States, Department of Commerce, 1991b, table 85, column 4 and United States, Department of Commerce and United States, Department of Labor, 1992, table 5).

The existing literature on this issue offers two diametrically opposed views. Some economists have observed "a striking difference in the response" of arm's-length and intra-firm trade to exchange-rate changes (Goldsbrough, 1981, p. 585). But others have concluded that "There is no compelling reason to believe that they react differently" to such changes (Bergsten *et al.*, 1978, p. 285).

This article revisits the debate in light of the "natural experiment" provided by the sudden, large depreciation of the United States dollar during the latter half of the 1980s. The first part seeks to determine whether or not the sharp drop in the dollar during the latter half of the 1980s elicited a trade response from United States-based TNCs. Trade responsiveness is gauged by looking at *changes* between 1985 and 1989 in the level of "United States content" (a concept that is defined below) in the products sold abroad by the foreign affiliates of United States-based TNCs. The results of this analysis are consistent with what would be anticipated normally. During the period 1985-1989, the foreign affiliates of United States-based TNCs showed a strong propensity to increase the United States content of the products they manufacture and sell abroad.

Having determined that United States-based TNCs exhibited trade responsiveness in the anticipated direction, the second part of the article seeks to compare the responsiveness of United States intra-firm and arm's-length exports. The analysis reveals that: (*a*) the distribution of industries in terms of intra-firm exports is quite different from that in terms of arm's-length exports; (*b*) if industry-mix differences are ignored, then, on an aggregate basis, intra-firm exports exhibit a less elastic response to the drop in the dollar compared with arm's-length exports; (*c*) but if industry-mix differences are properly accounted for, then the two types of exports—intra-firm and arm's-length—show virtually the same elasticity to a drop in the dollar; (*d*) finally, in terms of the speed of adjustment, intra-firm exports appear to have responded faster than arm's-length exports.

Based on these findings, the article concludes that TNCs, at least those based in the United States, are not an impediment to the trade adjustment process. Indeed, to respond to changes in the economic environment, both theory and evidence offer elements which suggest that TNCs may be better equipped to respond to changes in economic environment than firms that trade purely at arm's-length. This research is discussed in detail after the main arguments on both sides of the debate are fleshed out briefly.

The debate over intra-firm trade

Nearly three decades ago, Raymond Vernon (1966, p. 198) noted that TNCs with multiplant locations might source from low-cost facilities when it became apparent that such facilities were cheaper net of transport costs and tariffs. Similarly, on the basis of their modeling and research, Michael Adler and Guy Stevens (1974, p. 673) concluded that a dollar devaluation "*ceteris paribus* . . . increase[s] optimal MNC exports and . . . reduce[s] its equilibrium level of foreign production . . . in all instances . . .".

More recently, many scholars have argued that, due to their presence and often ready access to production capacity at home and abroad, United States TNCs might be in a special position to respond effectively to exchange-rate changes (Knetter, 1992, 1993; Lipsey and Kravis, 1986; Little, 1986, 1987 and Marston, 1991). Jane S. Little (1987, p. 46), who has argued on both sides of this debate, wrote that:

> "Firms with production and marketing facilities on both sides of an exchange rate possess an extra degree of flexibility in adjusting to a new competitive situation. These multinationals can turn to existing plants in countries where the currency is depreciating and, with comparative ease, expand output where relative production costs are falling . . . Accordingly, intra-firm trade might be expected to adjust more quickly to an exchange rate change than would trade between unaffiliated and noncooperating firms."

But several scholars, including Little herself, are skeptical of this view. For instance, Gerald Helleiner (1981, p. 3) wrote that intra-firm trade "can and usually do[es] take place in consequence of central commands rather than in response to price signals . . .". Likewise, Little (1986, p. 46) argued that "Because intra-firm trade is potentially 'managed' trade . . . the pace or size of its adjustment" differs "from that of trade between unaffiliated firms." Others (Cho, 1990; Encarnation, 1992) have argued similarly.

Advancing a slightly different hypothesis, David Goldsbrough (1981, p. 573) wrote that:

> "trade flows generated by the location decisions of a firm with large fixed investments in several countries may not respond as rapidly to shifts in relative prices as those of an independent producer . . . unconcerned with the effect of its actions on the profitability of overseas affiliates."

Goldsbrough (1981, p. 580) suggested that, since "integrated plants" within a TNC's network might produce specialized outputs which "have fewer close substitutes", the responsiveness of intra-firm trade may be further retarded. In order to examine the validity of his hypothesis, he analysed intra-firm and "conventional" (that is, arm's-length) United States imports between 1962 and 1976. He found that, while exchange-rate changes worked in the anticipated manner in his econometric regression explaining arm's-length imports, exchange-rate changes worked in the opposite manner in the case of intra-firm trade. A weaker dollar, Goldsbrough found, actually led to a rise rather than a decline in United States intra-firm imports. Consequently, he concluded that "there is a striking difference in the response of conventional and intra-firm United States imports to shifts in relative prices" (1981, p. 585); the latter do not seem to respond to changes in relative prices.

But the soundness of Goldsbrough's conclusion is questionable. Although his statistical analysis purports to cover the fifteen years from 1962 through 1976, there is only one year of actual data on intra-firm imports (that for 1966). As for the balance of the intra-firm data, Goldsbrough indicated in an appendix to his article that these are "extrapolated . . . from the . . . 1966 . . . [and] 1957" data (Goldsbrough, 1981, pp. 595-596).

More recently, Jane S. Little (1987) compared the growth in overall United States manufacturing exports between 1982 and 1984 (a period during which the dollar was appreciating) with the growth in intra-firm manufacturing exports over the same period. She found that, while overall exports grew by barely 4 per cent during this period, intra-firm exports grew by 27 per cent. This led her to conclude that intra-firm exports are less sensitive to exchange-rate changes than arm's-length exports. But Little herself acknowledged that if United States firms were setting up new affiliates abroad in response to the high dollar of the early 1980s, this might, under certain circumstances or in certain industries, help explain why United States intra-firm exports rose relatively more rapidly than arm's-length exports. For instance, if new (or even existing) foreign affiliates become responsible for serving the home as well as the host markets, and if they continue to source certain in-

puts (and capital equipment) from the parent firm, this may lead to the pattern observed by Little. In other words, what actually could have been a normal or above-normal degree of sensitivity to exchange-rate changes could be mistakenly interpreted as a below-normal response.

To be sure, there are sound arguments on the other side of the debate, too. For instance, it is unlikely that a TNC will abandon its operations in countries that have become relatively less cost competitive as a result of exchange-rate changes. Instead, the TNC might switch sourcing at the margin and to the extent feasible under the constraint of maintaining uncompetitive plants. But in deciding whether or not to adopt this middle-of-the-road approach, the TNC will have to factor in what might be called "unused capacity" or "non-varying" carrying costs *over and above* the normal costs that arm's-length traders would also take into account in deciding whether or not to switch their sourcing in response to the exchange-rate change.

Where they exist, these carrying costs (incurred for strategic and future-oriented reasons) are likely to create a drag on the adjustment process, since the exchange rate will have to cross a certain minimum *threshold* before it becomes optimal for the TNC to switch its sourcing. Obviously, the larger these carrying costs, the larger this threshold and, in practice, this threshold is likely to be greater for TNCs than for arm's-length traders.

To be sure, these carrying costs and the desirability and need to incur them will differ from industry to industry (being higher, for example, in the automobile industry than, say, in the computer industry), and perhaps even from host country to host country (depending on local regulations regarding layoffs, local content, export-performance requirements etc.). But previous studies have not addressed these issues.

Finally, there is the issue of *lags*. The issue of lags in trade adjustment was developed by Helen Junz and Rudolf Rhomberg (1973) in a seminal paper written over two decades ago. They suggested (1973, p. 413) a temporal taxonomy of lags consisting of: *recognition* lags (the time taken to "become aware of the changed competitive situation"), *decision* lags ("the time taken for new business connections to be formed and new orders to be placed"), *delivery* lags, *replacement* lags (the time taken to wear out or deplete existing stocks before new orders can be placed) and *production* lags (the time taken by producers to decide to switch old or add new capacity to service foreign markets).

Some scholars have argued that adjustment lags in intra-firm trade will be longer than those in arm's-length trade because the goods traded in the former are more likely to be intermediate in nature (Helleiner, 1978, p. 178). But *a priori* considerations might suggest just the opposite. For instance, it is highly likely that Junz and Rhomberg's recognition lag is smaller for TNCs than it is for arm's-length traders because, *ceteris paribus*, a key variable influencing the sourcing decision of the TNC, the real exchange rate, can be easily and almost costlessly observed by both foreign affiliates and parent firms.

Hence, regardless of whether or not the managers of TNCs adjust their transfer prices to reflect the new exchange rates, they are aware that sourcing changes could raise *overall* corporate profits. In this respect, hierarchies might bestow TNCs with important informational advantages over the competing institution of markets where relative price changes have to be actually observed before they can be acted upon.[1]

Similarly, Junz and Rhomberg's decision lag might also be shorter for TNCs, which typically have a well-established network of manufacturing affiliates in several countries, as might production lags: presumably, since TNCs already operate via affiliates elsewhere, they possess better information and experience on this front as well, and might once again be ahead of the game *vis-à-vis* arm's-length traders.

To summarize, in principle, arguments can be made on both sides of whether or not TNCs will respond as vigorously as arm's-length traders to a given exchange-rate change. Whether or not they do, therefore, is an empirical question. On the issue of the speed of responsiveness, based upon the information advantages enjoyed by TNCs, it could be anticipated that intra-firm trade responds faster to exchange-rate changes than arm's-length trade. Unfortunately, limited as it is, prior empirical work in this area is weak and leaves important doubts, especially on the effects of industry-mix differences between intra-firm and arm's-length trade.

In an effort to move this line of research forward, the balance of this article takes a fresh look at the evidence.

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[1] It would be incorrect to leave the impression that the only information required to make a sourcing shift decision within a TNC is the real exchange rate. To be sure, information on the switching and other (unused capacity "carrying") costs will also be required.

The sourcing responses of United States transnational corporations

When the United States dollar depreciated sharply in real terms during the latter half of the 1980s, the foreign affiliates of United States-based TNCs were presumably presented with an economic incentive to increase the United States content and decrease the local content of the products they manufactured abroad. Did they, in fact, undertake such a substitution and, if so, to what extent? Was such a substitution greater in those countries against whose currencies the dollar depreciated relatively more? Did the substitution move in the opposite direction with countries (like Malaysia) against whose currency the dollar *appreciated* during this period? These are the questions that this section will address.

The analysis is conducted from the perspective of United States majority-owned foreign affiliates (MOFAs) engaged in manufacturing. Data availability limits the analysis to *majority*-owned affiliates, and substitution-possibility considerations guide the focus on manufacturing (as opposed to wholesaling) affiliates.

In terms of geographic scope, the analysis is limited to the operations of United States-based TNCs in countries hosting significant shares of United States foreign direct investment (FDI). Twenty such countries were identified initially, but two, Brazil and Mexico, were excluded due to data problems.[2] Although small in number, the eighteen remaining countries account for nearly 90 per cent of all sales made by United States manufacturing MOFAs worldwide (United States, Department of Commerce, 1991b, table 32, column 3). Descriptions of the variables measured and the estimation methods used, as well as a listing of the sources, are presented in box 1.

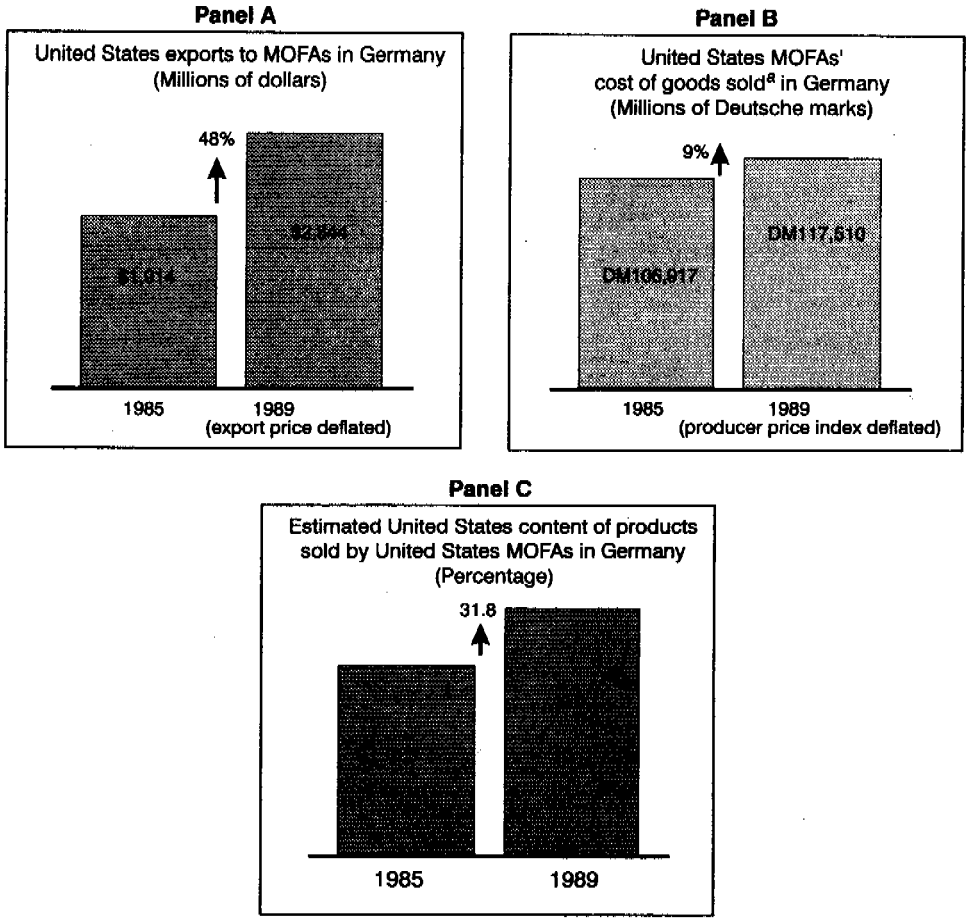
How did United States majority-owned foreign affiliates in Germany respond to the dollar's drop?

The method by which the trade responsiveness of United States-based TNCs is measured is best explained by looking at the sourcing behaviour of United States MOFAs in a single country. Germany is an example.

[2] The eighteen remaining economies are: Australia, Belgium, Canada, France, Germany, Hong Kong, Ireland, Italy, Japan, Republic of Korea, Malaysia, Netherlands, Philippines, Singapore, Spain, Switzerland, Taiwan Province of China and United Kingdom. As mentioned in the text, Brazil and Mexico could not be included without weakening the robustness of the overall quantitative estimates. The primary problem was that both these countries suffered high inflation and related dramatic exchange-rate changes during the 1980s.

Figure 1. How United States MOFAs in Germany responded to the depreciation of the dollar between 1985 and 1989

(Millions of dollars and Deutsche marks and percentage)



Source: See table 1.

[a] This is used as a proxy to estimate changes in "volume" of final product sales.

The dollar depreciated by roughly 43 per cent in real terms against the mark between 1985 and 1989. As panel A in figure 1 shows, partially due to this and partially due to other factors (primarily growth in German incomes), United States exports to United States MOFAs in Germany grew by 49 per cent in real (i.e., "volume") terms, from $1.9 billion to $2.8 billion.

Given that the bulk (85 per cent) of United States exports to United States MOFAs is in the nature of inputs to final products manufactured abroad (United States, Department of Commerce, 1991b, table 71, columns 1 and 2) (i.e., *derived demand*), the focal question is: was the 49 per cent rise in exports merely a response to an equivalent rise in the demand for the final products sold by United States MOFAs in Germany, or was it largely a response to the incentive to substitute United States inputs for the now relatively more expensive German inputs?

Panel B in figure 1 provides the answer. The panel shows that, between 1985 and 1989, the volume of United States MOFAs' final product sales in Germany grew not by 49 per cent, but by just 10 per cent. By implication, as panel C of the figure shows, the *United States content* of products sold by United States MOFAs in Germany rose relatively sharply between 1985 and 1989, going from 5 per cent to 7 per cent.[3] Though small in absolute terms, the change represents a rise of over 30 per cent in the level of United States content. Whether this response was small, normal, or large cannot, of course, be answered in the abstract; one will need to look, as the next section does, at how United States MOFAs in other countries responded to similar exchange-rate changes.

How did the United States content level move in other countries?

Table 1 summarizes the relevant information for the eighteen countries considered. The first three columns of the table show, for each country, the changes in the dollar's real bilateral exchange rate, changes in the volume of United States exports to MOFAs located in the country, and changes in the volume of final goods sales of United States MOFAs located in the country.

[3] United States content levels are measured by dividing United States exports to MOFAs in a particular country by the total costs (net of exchange-rate translation effects) incurred by MOFAs operating in that country. Note, both intra-firm and arm's-length United States exports to MOFAs are, as they should be, included in the numerator. Using intra-firm exports alone would be incorrect, but would not affect the estimates very much since the intra-firm portion accounts for close to 90 per cent of the numerator. For details, see box 1, pp. 76 et seq.

Table 1. Changes in exchange rates, United States exports to MOFAs, MOFAs' cost of goods sold and United States content of United States manufacturing in eighteen economies, 1985-1989

(*Percentage*)

Economy	1985-1989			United States content in MOFAs' total cost of goods sold		
	Change in dollar's real exchange rate	Change in "volume" of United States exports to MOFAs	Real change in MOFAs' cost of goods sold	1985	1989	Change
Australia	34.9	25.9	13.0	10.1	11.1	10.0
Belgium	26.2	12.3	14.4	12.4	11.7	–5.7
Canada	17.0	9.8	8.7	40.6	38.9	–4.2
France	39.9	23.1	18.6	6.3	6.4	1.8
Germany	42.9	48.6	9.9	5.3	6.9	31.8
Ireland	32.3	42.7	47.1	24.3	22.3	–8.4
Italy	45.0	75.8	25.7	5.1	6.9	37.1
Japan	41.1	95.7	32.5	10.5	14.6	38.6
Netherlands	43.9	58.6	14.5	10.0	13.3	31.9
Spain	44.1	429.4	28.0	3.0	11.8	298.9
Switzerland	42.6	23.9	–32.3	4.9	8.7	77.7
United Kingdom	38.3	51.2	29.4	7.2	8.2	14.9
Hong Kong	18.0	36.5	101.8	22.3	15.1	–32.4
Korea, Republic of	22.9	129.7	97.0	40.0	42.1	5.4
Malaysia	–10.3	–12.3	51.3	44.8	26.6	–40.6
Philippines	6.0	–12.7	5.2	21.6	18.5	–14.4
Singapore	–4.7	113.5	116.2	28.8	27.5	–4.3
Taiwan Province of China	29.0	48.2	76.0	17.1	13.8	–19.2

Source: See box 1 and table 5.

The next two columns show the United States content levels in 1985 and 1989 of United States MOFAs operating in these countries. And the last column shows the percentage change in United States content in the intervening period.

Several comments are in order. First and most importantly, as in Germany, in nine other countries the level of United States content in products sold by United States MOFAs rose between 1985 and 1989. In another two (Malaysia and Singapore), the dollar had appreciated *vis-à-vis* the domestic currency. So, in twelve out of the eighteen countries the estimated substitution behaviour of United States TNCs was in accordance with the *a priori* expectations (given the exchange-rate movements).

Three of the remaining six economies (Hong Kong, the Philippines and Taiwan Province of China) where United States content levels fell during this period are newly industrializing economies. Whether the sourcing behaviour of United States MOFAs is influenced by the cost-reducing rather than market-seeking nature (Eden and Molot, 1992a) of United States FDI in these newly industrializing economies is not discussed here.[4] But, as shown below, in at least one of these economies (the Philippines), the mix of industries in which United States firms operated had changed substantially between 1985 and 1989.[5]

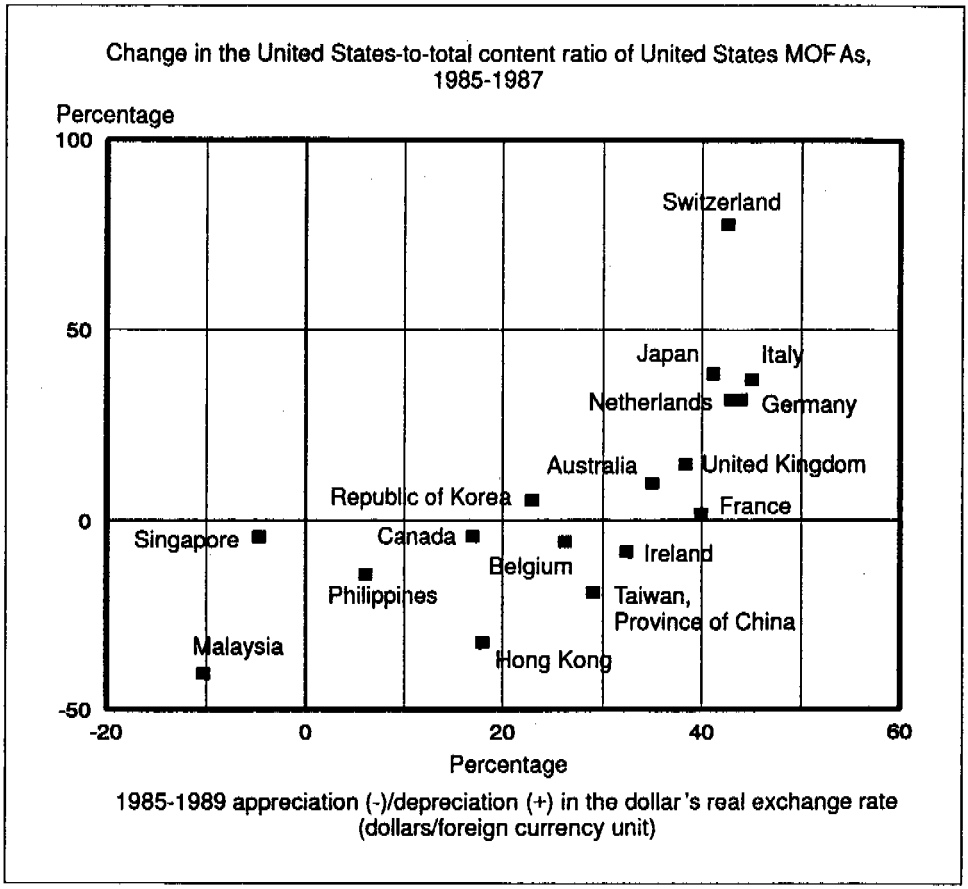
The overall picture that these data portray can be seen in figure 2, which plots the changes in the United States content levels in these countries against changes in the real exchange rate. It is clear that rising United States content levels co-vary with falling values of the dollar. In fact, ordinary least squares (OLS) regression analysis suggests that, *ceteris paribus*, over this period, every 1 per cent drop in the United States dollar's real exchange rate

[4] Some indication of the cost-reducing intent of United States FDI in Asia (excluding Japan) is given by the fact that, in 1988, more than 60 per cent of the output of United States MOFAs (engaged in electrical and non-electrical machinery) in that region was sold back to the United States, while less than 20 per cent of the output was sold locally. The comparable figures for United States MOFAs in the same industries in developed countries were 10 per cent and 60 per cent, respectively (Vernon and Rangan, 1991, table 4-2).

[5] Before proceeding, a comment about Spain is in order, since it stands out rather dramatically in terms of both the rise (of 429 per cent) in United States exports to United States MOFAs, and the rise (of 299 per cent) in the level of United States content. The Bureau of Economic Analysis—the source of the base data—indicates that the figures for Spain are skewed by the responses of one particular TNC in 1989 (conversation with Mr. Raymond Mataloni of the Bureau of Economic Analysis). But further information was not divulged due to confidentiality reasons, and these data could not be adjusted in a meaningful manner. Spain, therefore, is excluded from the overall quantitative analysis so that the responsiveness of United States TNCs to exchange-rate changes is not overestimated.

Figure 2. Changes in the real exchange rate versus changes in the United States-to-total content ratios of United States manufacturing MOFAs for seventeen economies,[a] 1985-1989

(*Percentage*)



Estimated elasticity: 1.25; *t*-statistic: 4.10;
intercept: –0.27; *t*-statistic: –2.78; $n = 17$;
adjusted R-squared: 0.50; F-ratio: 16.82

Source: See table 1.

[a] Excluding Spain.

led to a 1.25 per cent rise in the United States content level of United States manufacturing MOFAs. This estimated elasticity coefficient of 1.25 passes the standard *t*-test at the 99 per cent level, and, together with a constant term, explains half of the total variation in changes in United States content levels between 1985 and 1989 (see box at the bottom of figure 2).

An estimate of the elasticity of substitution can be obtained by extending this analysis slightly. The elasticity of substitution measures the responsiveness of the ratio of United States-to-local content to relative price changes. Mathematically,

$$\sigma = \frac{\%\ \Delta\ \text{(United States content/local content)}}{\%\ \Delta\ \text{(dollar's real exchange rate)}},$$

which, with these data, is estimated at 1.48. This estimate is well within the range of those reported in earlier, more conventional, studies of elasticities of substitution in international trade (Stern *et al.*, 1976, p. 224; Kravis and Lipsey, 1974, p. 265).

Industry-mix issues and related concerns

A few important concerns need to be addressed before concluding confidently that the changes in Unites States content levels seen in figure 2 were indeed driven primarily by exchange-rate changes and not other factors. These concerns relate to industry-mix issues. At the heart of this issue lies the concern that the rise in United States content observed above is unrelated to the dollar's depreciation. This could be the case if what changed between 1985 and 1989 was not United States MOFAs' sourcing behaviour, but the mix of manufacturing industries in which they operated in the host countries.

Specifically, if United States FDI in a United States input-intensive industry grew disproportionately in a particular host country between 1985 and 1989, then even if none of the individual United States MOFAs in that country raised their United States content levels, the method employed above would produce a result indicating that the United States content level in that country had increased. While factually correct, this result would have no connection with TNC substitution behaviour and responsiveness to exchange-rate changes.

There are two ways to check whether the substitution effects observed in the previous section are real. Both indicate that industry-mix changes

do not account for the rise in United States sourcing observed at the country level. The two methods and their results are discussed below.

First, if mix changes, not substitution effects, "caused" the United States content levels to rise in the countries considered above, then a country-by-country comparison should show changes in the industry mix of United States MOFAs in 1989 compared with 1985. But, the Pearson coefficients of correlation (displayed in table 2), suggests that, almost across the board, industry mix in 1989 was very similar to the mix in 1985.

Of course, it is possible that in the case of Switzerland, industry-mix changed because, as seen in table 1 (column three), it is the only country in which United States MOFAs actually showed a rather substantial drop in the volume of final goods' sales. But even when the coefficient of the elasticity of substitution is re-estimated without Switzerland, the thrust of the findings holds firmly. The coefficient drops from 1.5 to 1.3, but the explanatory power of the regression rises somewhat from 0.53 to 0.58.

A second and more direct method by which to check whether industry-mix changes, rather than exchange-rate changes, account for the observed higher United States content levels between 1985 and 1989 is to examine the substitution effects at the industry level (instead of at the country level). As table 3 shows, the picture at the industry level (seen by comparing the last column in the table with the first column) is very similar to that at the country level. With the exception of United States MOFAs in the transportation-equipment industry, MOFAs in all other industries raised their United States content levels in response to the depreciation of the dollar.

Perhaps not surprisingly, MOFAs in commodities industries—food and metals—exhibited a higher elasticity of substitution than those in other industries, such as chemicals, non-electrical machinery and electric and electronic equipment. While MOFAs in the latter industries responded with an elasticity of around one, MOFAs in the food industry responded with an elasticity of two, and those in metals with an elasticity of just under two (not shown). And consistent with an earlier speculation, MOFAs in the automobile industry seem to have responded the least to large exchange-rate changes. In fact, what little responsiveness they showed, appears to be in the "wrong" direction, that is, automobile MOFAs seem to have lowered rather than raised their United States content levels between 1985 and 1989.

To be sure, the motor vehicles and parts industry qualifies as a special case, because the bulk of United States trade and investment in this industry

Table 2. Stability of the industry mix of United States manufacturing MOFAs in eighteen economies, 1985 and 1989

(*Correlation coefficients and number of industries*)

Economy	Correlation[a] between industry mix, 1985 and 1989 (*p* values in parentheses)		Number of industries[b] in test (out of a maximum of 7)
Canada	0.972	(0.000)	7
Belgium	0.977	(0.004)	5
France	0.98	(0.000)	7
Germany	0.949	(0.001)	7
Ireland	0.998	(0.038)	3
Italy	0.939	(0.002)	7
Netherlands	0.987	(0.000)	6
United Kingdom	0.942	(0.001)	7
Australia	0.999	(0.027)	3
Japan	0.954	(0.194)	3
Spain	0.941	(0.017)	5
Switzerland	-0.887	(0.306)	3
Hong Kong	1.000	(0.012)	3
Malaysia	1.000	(0.062)	3
Philippines	0.494	(0.671)	3
Singapore	0.922	(0.078)	4
Korea, Republic of	1.000	(1.000)	2
Taiwan Province of China	0.804	(0.196)	4

Source: United States Department of Commerce (1988 and 1991b), table 29 and table 32.

[a] Pearson correlation coefficient between the shares of various industries in the total manufacturing sales of United States MOFAs in the country under consideration in 1985 and 1989.

[b] The seven manufacturing industries are food and kindred products; chemicals and allied products; primary and fabricated metals; machinery except electrical; electric and electronic; transportation equipment; other manufacturing.

takes place under special agreements with Canada and Mexico (see Eden and Molot, 1992b for a recent treatment of this issue). These agreements constrain the adjustment possibilities of United States firms, particularly with regard to switching out of local content. For instance, the United States agreement with Mexico stipulates that every dollar's worth of cars imported by United States MOFAs in Mexico must be matched by two dollars' worth of exports; the corresponding ratio for parts is one to one (Hufbauer and Schott, 1993, p. 39). Canada imposes similar local content rules, essentially stipulat-

Table 3. Changes in exchange rates, United States exports to MOFAs, MOFAs' cost of goods sold and United States content of United States manufacturing MOFAs, by industry, 1985-1989

(Percentage)

Industry	1985-1989			United States content in MOFAs' total cost of goods sold		
	Change in dollar's real exchange rate	Change in "volume" of United States exports to MOFAs	Real change in MOFAs' cost of goods sold	1985	1989	Change
Total manufacturing	25.0	24.2	20.3	17.0	17.5	3.2
Food and kindred	26.1	65.7	9.9	3.6	5.4	50.8
Chemicals and allied	27.0	30.3	7.9	8.7	10.5	20.8
Primary and fabricated metals	24.6	35.1	−1.5	8.0	10.9	37.1
Machinery except electrical	27.6	67.4	42.1	15.4	18.1	17.8
Electric and electronic equipment	21.7	24.7	7.2	22.6	26.3	16.3
Transportation equipment	22.3	5.6	17.6	33.6	30.2	−10.2

Sources: Calculated based on data by the United States Department of Commerce (1988), table 28, cols. 7 and 9; table 51, col. 1; and (1991b), table 31, cols. 7 and 9; table 32; and table 65, col. 1. Export prices by sector are from the United States Department of Commerce, Bureau of Labor Statistics (1992), classified by SIC, period averages used for 1989. Exchange rates (rf quotes) are from the International Monetary Fund (1991). National producer prices are those used in table 1.

Note. Industry exchange rates and producer prices are weighted by country shares in total sales of manufacturing MOFAs in a particular industry in the 16 most important economies (which account for 85 per cent of total worldwide sales). Mexico and Brazil are excluded due to their high inflation rates. MOFAs' cost of goods sold is deflated by the country-weighted industry-specific producers' price index and by a weighted United States export price for imports from the United States.

ing that for every car sold in Canada, a car must be made in Canada (Eden and Molot, 1992b).[6]

This raises one final question: did the automobile industry unduly influence the overall picture? Could it be that United States MOFAs in Canada did not raise their United States content levels by as much as, say, United States MOFAs in Japan, because the former, but not the latter, are highly concentrated (up to 47 per cent) in the automobile industry? In order to answer this question, the elasticity of United States content was re-estimated after controlling for the share of United States MOFAs in the automobile industry in each country.[7] The elasticity coefficient did not change either in magnitude or in statistical significance. (The coefficient stayed at 1.25, while the *t*-statistic dropped slightly from 4.10 to 3.95.) As anticipated, the coefficient of the automobile industry's shares was negative, but it was small (at −0.011) and not statistically significant (*t*-statistic of −0.027). The adjusted *R*-squared of the new specification dropped slightly (from 0.50 to 0.46). Thus, it seems reasonable to conclude that industry-mix changes did not "cause" the pattern of responsiveness seen in figure 2. Exchange-rate movements still appear to offer the most compelling reason for the systematic changes observed in the sourcing behaviour of United States TNCs.

Did intra-firm exports respond less vigorously than arm's-length exports to changes in the exchange rate?

Having determined that the trade of United States-based TNCs responded to exchange-rate changes in the anticipated manner, the article now examines whether or not this response was as vigorous and as quick as that exhibited by arm's-length trade. As before, the period of focus is the latter half of the 1980s.

As the first two columns of table 4 show, on an unadjusted basis, United States intra-firm manufacturing exports grew by less than overall (i.e., arm's-length plus intra-firm) United States manufacturing exports dur-

[6] Of course, without examining whether or not these constraints were binding at the time of the dollar depreciation, these export and other performance requirements cannot be implicated in the apparent lack of responsiveness of United States MOFAs in this industry. But given the quite large (22 per cent) drop in the value of the dollar that MOFAs in this industry experienced, it would seem reasonable to place these institutional aspects high on the list of possible causal factors that merit investigation.

[7] This was done by including on the right hand side of the regression equation an independent variable whose value was based on the share of automobiles in total sales of United States MOFAs in each country.

ing the period 1985-1989. While the latter grew by 65 per cent, the former grew only by 47 per cent.[8] To be sure, this 1.4 to 1 ratio of growth rates is considerably smaller than the 7.1 to 1 ratio reported by Little (1987, p. 48) for the period 1982-1984, but it is none the less consistent with the commonly held view that intra-firm trade responds rather sluggishly in comparison to arm's-length trade. But as the two centre columns of table 4 show, there is a visible difference in the mix of industries in which arm's-length and intra-firm trade occurs. Intra-firm trade is heavily concentrated in five industries: chemicals and allied products, non-electrical machinery, electrical equipment, motor vehicles and parts, and instruments and related products. These industries account for 92 per cent of United States intra-firm exports, but only for 70 per cent of overall United States manufacturing exports.

Given these sharp differences in industry mix, unadjusted comparisons between growth rates in intra-firm and arm's length exports will be misleading. To be meaningful, comparisons need to be made on an industry-by-industry basis. When this is done, three of the five key industries show very similar overall and intra-firm growth rates: 64 and 66 per cent in chemicals; 27 and 25 per cent in motor vehicles, and 100 and 85 per cent in instruments. Although large differences persist in the non-electrical and electrical machinery industries, only the latter shows faster growth in arm's-length exports. In non-electrical machinery, intra-firm exports grew much faster than arm's-length exports. When these two industries are lumped together under the category of machinery, arm's length and intra-firm growth rates converge at 57 per cent (figures not shown in the table).

It is, therefore, not surprising that, on an industry mix-adjusted basis, there is virtually no difference between the growth in overall and intra-firm manufacturing exports (see the last two columns of table 5). While overall United States manufacturing exports grew by 52 per cent between 1985 and 1989, United States intra-firm manufacturing exports grew by 51 per cent over the same period.

But how can the puzzling and vastly different overall and intra-firm export growth rates (of 46 per cent and 74 per cent) in the electrical and (of 79

[8] The aircraft and parts industry is excluded from this analysis because, for reasons related to scale economies and, perhaps, national security, there is almost no *intra-firm* trade in this industry. If this industry had been included in the growth rate calculation, overall United States manufactured exports would show a growth of 65.6 per cent, while intra-firm exports would show a growth of 47.6 per cent—figures very similar to those appearing in the main text.

Table 4. Growth in overall United States manufacturing exports versus growth in United States parent firms' intra-firm exports, 1985 and 1989

(*Percentage*)

Industry	Unweighted change in United States manufacturing exports		Industry share in combined 1985 and 1989 United States exports		Industry share weighted change in United States manufacturing exports	
	Overall	Parent firms' intra-firm	Overall	Parent firms' intra-firm	Overall	Parent firms' intra-firm
All manufacturing, excluding petroleum and transportation equipment other than motor vehicles and parts	65.4	47.0	100.0	100.0	51.5	50.5
Food and kindred products	47.4	23.6	6.5	2.1	1.0	0.5
Tobacco	186.4	139.4	1.3	0.3	0.6	0.4
Textiles and apparel	113.6	125.0	2.0	0.3	0.9	0.4
Lumber, wood, furniture and fixtures	123.6	94.3	2.7	0.2	0.3	0.2
Paper and allied products	402.9	294.9	3.1	0.8	0.8	2.2
Printing and publishing	77.3	21.5	0.9	0.3	0.2	0.1
Chemical and allied products	64.4	65.6	15.1	14.0	9.0	9.2
Rubber and miscellaneous plastics	60.7	41.6	1.9	1.2	0.7	0.5
Stone, clay, glass and concrete	63.7	43.9	1.2	0.5	0.3	0.2
Primary metals products	156.9	84.2	4.2	1.1	1.5	0.6
Fabricated metals	49.4	43.3	8.8	0.8	0.4	0.3
Machinery, except electrical	85.5	74.1	24.0	26.2	11.9	19.4
Electrical equipment and supplies	78.9	21.0	13.8	10.1	8.0	2.1
Motor vehicles and parts	26.7	25.3	10.6	35.4	9.4	8.9
Instruments and related parts	99.8	84.8	6.8	6.5	6.9	5.5
Miscellaneous (including leather)	168.7	-16.0	2.2	0.3	0.6	-0.1

Source: United States export data from the United States Department of Commerce and the United States Department of Labor, February 1988 and March 1992, table 5; and intra-firm export data from the United States Department of Commerce (1988): table 57, col. 4; and (1991b), table 85, col. 6.

Table 5. Selected data on United States parent firms' manufacturing MOFAs in eighteen economies, 1985 and 1989

(Billions of dollars)

Economy	United States exports to MOFAs in manufacturing			MOFAs' estimated total cost of goods sold		
	1985	1989 nominal	1989 real[a]	1985	1989 nominal, at 1989 exchange rates	1989 real, at 1985 exchange rates[b]
Australia	1.1	1.5	1.3	10.5	16.5	12.0
Belgium	1.1	1.4	1.2	8.6	15.2	10.2
Canada	27.1	32.9	29.8	66.7	91.0	76.5
France	1.1	1.6	1.4	18.3	32.3	22.1
Germany	1.9	3.2	2.8	36.3	66.3	40.9
Ireland	0.8	1.2	1.1	3.2	6.8	4.9
Italy	0.5	1.0	0.9	10.4	21.3	13.4
Japan	1.0	2.1	1.9	9.1	19.6	12.8
Netherlands	1.2	2.1	1.9	11.6	20.4	14.0
Spain	0.2	1.3	1.2	7.5	15.8	9.0
Switzerland	0.1	0.1	0.1	1.7	1.7	1.2
United Kingdom	2.6	4.4	4.0	36.8	71.7	48.5
Hong Kong	0.2	0.4	0.3	1.1	2.8	2.2
Korea, Republic of	0.2	0.5	0.5	0.5	1.4	1.2
Malaysia	0.8	0.8	0.7	1.8	2.7	2.7
Philippines	0.3	0.3	0.2	1.2	1.4	1.3
Singapore	0.7	1.7	1.6	2.5	6.7	5.6
Taiwan Province of China	0.3	0.5	0.5	1.8	4.1	3.3

Source: United.States exports to MOFAs are from the United States Department of Commerce (1988), table 52, col. 3; United States Department of Commerce (1991b) table 68, col. 3. Export prices by sector are from the United States Department of Labor (1992b), classified according to the Standard International Trade Classification, period averages used for 1989. Industry weights used in export-price calculations are from the United States Department of Commerce (1991b), table 66. Cost of goods sold for 1989 are from the United States Department of Commerce (1991b), col. 3 in tables 32, 34, 35. Exchange rates (rf quotes) are from the International Monetary Fund (1991), Board of Governors, Federal Reserve Bank (for Taiwan Province of China), and the United Nations (1991) (for Hong Kong). Producers' price index weights are from the United States Department of Labor (1990), table 29.

[a] Deflated by a weighted average United States export price index for 1989 (see box 1 for details).

[b] Imports from the United States are deflated by a weighted average local-producer price index. Local costs are stated at 1985 exchange rates (see box 1 for details).

per cent and 21 per cent) in the non-electrical machinery industries be explained? And why might the differences run in the opposite directions in these two industries? One simple explanation is that classification, not behavioural differences, lies at the bottom of this puzzle. This explanation rests on the fact that the intra-firm trade data are classified by the *industry* of United States parent firms, while the overall (or "conventional") trade data are classified by *product*.

To see how this might produce the results seen above, consider an example (based upon a report in the *New York Times*). The IBM Corporation exported over $1 billion worth of semiconductor chips to its majority-owned affiliate in Japan in the late 1980s, early 1990s time period.[9] Since IBM, the parent firm, is in the computer industry, its intra-firm chip exports and the growth in these exports will be accounted for in the non-electrical-machinery industry (under "office and computing machines"). But since the *product* exported was computer chips, in the balance of payments data these $1 billion worth of intra-firm exports will be accounted for in the electrical-machinery industry (under "electronic components"). If IBM's (and other computer companies') intra-firm chip exports from the United States to Japan and other countries had risen significantly in response to the sharp depreciation of the dollar *vis-à-vis* the yen (and/or due to a rise in demand abroad for IBM chips during this period) then, given the way these data are classified, the non-electrical machinery industry would show a steep rise in intra-firm exports (but not in overall exports), while the electrical-machinery industry would show a steep rise in overall exports (but not in intra-firm exports). And this alone could produce a pattern like the one observed above.

In fact, analysis conducted at lower levels of industry aggregation strongly supports the hypothesis that classification differences matter. Of course, this is not to say that there are no behavioural differences contained in the puzzling pattern observed above. But it appears that a simple explanation based upon classification differences might, in and by itself, go a long way towards reconciling the observed differences in the growth rates of intra-firm and arm's-length machinery exports.

[9] Keith Bradsher, "Japan buys too few chips, U.S. finds," *New York Times*, 3 August 1992, Business Section, p. 2. The article reports that, had IBM's United States chip exports to its Japanese affiliate been counted in the calculation, United States producers would have accounted for an extra two percentage points of the Japanese semiconductor market of $54.6 billion. This is the basis on which it is estimated that IBM exports $1 billion worth of chips to Japan.

Did intra-firm exports respond as quickly as arm's-length exports to the 1985-1989 exchange-rate change?

Based on the earlier discussion on the information advantages that TNCs possess and given that the dollar depreciated dramatically (thus making it more likely that switching thresholds were crossed), it could be anticipated that intra-firm trade actually responded faster than arm's-length trade to the post-1985 exchange-rate change. And, indeed, the pattern of adjustment visible in the data is consistent with these expectations.

Panel A in figure 3 compares the *unweighted* export growth in overall and intra-firm exports. Panel B compares growth rates that have been adjusted to account for industry mix differences between intra-firm exports and all United States exports. Both panels are plotted in log space in order to highlight better differences in growth rates.

First, it is clear that there is a three- to four-year lag (beginning in March of 1985, when the dollar began its precipitous drop) before rapid export growth rates kick in. This multi-year lag is consistent with Junz and Rhomberg (1973) early findings. Second, as can be seen in panel A even when industry-mix differences are not adjusted for, intra-firm exports appear to respond slightly faster than arm's-length exports to the drop in the value of the dollar. But when industry-mix differences are adjusted for, intra-firm exports, as can be seen in panel B, show a substantially faster response than arm's length exports (four per cent to 0.3 per cent). Third, intra-firm exports continued to grow more quickly than arm's-length exports for almost three years after the dollar began to drop.

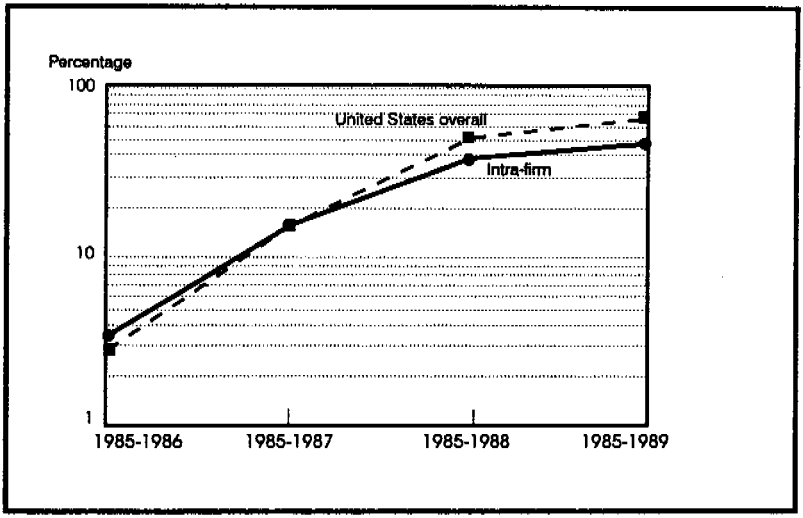
To be sure, not much can—and should—be read into the relatively small differences observed in growth rates.[10] But there is little evidence in these data to support the view that intra-firm exports respond to exchange-rate changes more sluggishly than arm's-length exports.

[10] Furthermore, this comparison becomes problematic if the mix of countries for which intra-firm exports are destined is different from that for which arm's-length exports are destined. This could mean that the two kinds of exports face different demand effects in addition to different average exchange-rate effects. A simple comparison of export growth rates could conflate the two effects. Examining the substitution responses of United States TNCs provides a better methodological approach to this issue since it controls for income changes and focuses directly on behavioural responses to relative price changes.

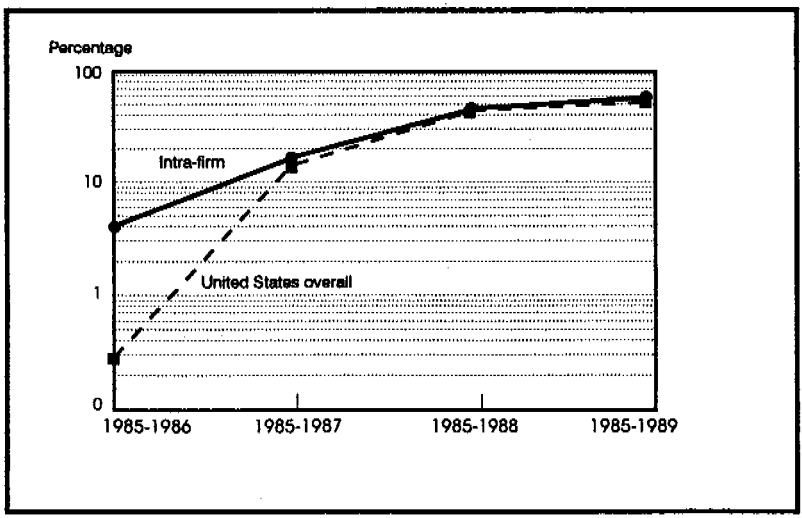
Figure 3. Lags in the adjustment of United States intra-firm and overall manufacturing exports, 1985-1989

(*Percentage*)

Panel A: Unweighted growth in exports (plotted in log space)



Panel B: Weighted average growth in exports (weights are industry shares in intra-firm exports)



Sources: Overall export data are from the United States Department of Commerce and the United States Department of Labor (1988-1992) and intra-firm export data are from the United States Department of Commerce (1988 and 1991b).

Conclusions

The evidence from the 1985-1989 dollar depreciation episode supports the assertion of C. Fred Bergsten *et al.* (1978, p. 285), who wrote more than fifteen years ago that:

> "At both the microeconomic and macroeconomic levels . . . there are strong reasons to be skeptical of the view that multinational enterprises undermine the adjustment process. There is no compelling reason to believe that they react differently than other firms to exchange-rate (and other price) changes."

From a policy perspective, this is important because it implies that TNCs are not an impediment to trade adjustment. Put differently, it implies that the extent to which economic integration occurs across borders but within firms does not affect significantly the powerful role of exchange rates in the economy. Whether or not this proposition holds when applied to tax, labour, environmental, and other national regulations that can shift a country's relative competitiveness is a question on which this article can provide only a basis for speculation.

Many important questions remain to be fleshed out. The most obvious among them is the question of what happens in the case of home-currency appreciation. Would the trade and sourcing responsiveness of TNCs to a sustained appreciation be symmetric to that in the case of a depreciation? In principle, the answer would appear to be a qualified yes. Indeed, to the extent that these are indicative, the trade and sourcing responses of Japanese TNCs to the persistently strong yen of the late 1980s and early 1990s appear to corroborate this. But only careful study can provide a reliable confirmation. Further, are there asymmetries in the speed at which intra-firm trade responds to appreciations versus depreciations? This, too, remains to be explored.[11] Reasonable arguments can be made on both sides of this question, and resort may again have to be made to empirical analysis. Also remaining to be explored is the question of whether globalization has increased the ability of TNCs to respond more effectively to such changes.

[11] On the matter of relative speed, it would appear that, since shedding capacity in the United States is relatively easy for firms, the response of intra-firm exports to dollar appreciations would be fairly quick and strong (assuming that the right kind of excess capacity exists abroad). On the other hand, an important factor pushing against a speedy response by United States firms to a high dollar (in the form of expanding foreign capacity and contracting United States capacity) is the difficulty of shedding foreign capacity once created.

Box 1. Concepts and methods of estimation

The purpose of this box is to define and explain how the variables used in estimating the *elasticity of United States content* and the *elasticity of substitution* were calculated. It therefore focuses on the data shown in tables 1 through 3.

- *Elasticity of United States content.* In simple terms, the exchange-rate elasticity of the United States content of products sold by United States MOFAs in any particular country is estimated by dividing the percentage change in the United States content levels of these affiliates between 1985 and 1989 in that country by the percentage change in the dollar's real exchange rate *vis-à-vis* that country's domestic currency.

- *United States content level.* The United States content level of United States MOFAs in any particular country is measured by dividing the quantity of United States inputs of these MOFAs in any given year by the total "cost of goods sold" (COGS) that they incurred in that same year. In all cases, the calculations are done in *volume* terms, that is, the United States content and changes in it are *volume* measures, not *value* measures. In the case of United States exports, this means that the dollar value of exports is divided by the appropriate United States export prices. And in the case of local cost of goods sold, this means that currency translation and local cost-change effects are removed from the calculations. These deflated figures should give a reasonably accurate estimate of changes in the actual volume of United States exports, MOFA's output and changes in the United States content levels.

- *Elasticity of substitution.* The elasticity of substitution is related to the elasticity of United States content concept described above. The key difference is that while the latter measures the response of the United States to *total* content level to exchange rate changes, the former measures the response of the United States-*local* content level to exchange rate changes. Denoted by σ_A, the exchange rate elasticity of substitution exhibited by United States MOFAs between 1985 and 1989 in foreign country A is given by:

$$\text{Percentage change (1985–1989)} \left\{ \frac{\text{United States manufacturing exports to MOFAs in country A, export price deflated and in United States dollars}}{\text{Total COGS of MOFAs in A, deflated and translated into dollars at 1985 exchange rates}} \right\} \Big/ \left\{ \frac{\text{United States mfg. exports (same as numerator)}}{P} \right\}$$

Percentage change (1985–1989)

where e is the nominal exchange rate stated in terms of dollars per unit of foreign currency, P_A is the producer price index in country A and P is the United States producer price index.

The "cost of goods sold" is the sum of the costs incurred by United States MOFAs locally and in procuring United States inputs. Since these were not directly available, the total costs were estimated by substituting into the following accounting identity United States MOFAs' net income, income tax payments and sales:

Sales − Costs = Income tax + Net income after tax.[a]

- *Deflation.* As noted above, United States exports shipped to manufacturing MOFAs are deflated by an industry-weighted average United States export price index (base 1985), and local costs are deflated by an industry-weighted average local producer price index.[b] The industry weights used in calculating the average export price deflator for each host country are based upon the industry shares in United States exports shipped to MOFAs in that country in 1989 (the only year for which such data are available). Industry weights used in calculating the average local producer price deflator for each country are based upon industry shares in MOFAs' total manufacturing sales in that country in 1987.

- *Change in volume of final product sales.* The change in the volume of United States MOFAs' final product sales between 1985 and 1989 is estimated based upon changes in these MOFAs' deflated cost of goods sold. Since these costs have been adjusted for currency translation and inflation, they should provide a reasonable proxy for changes in the volume of output shipped. As mentioned in the article, this is how changes in local demand (due to income and other effects) are controlled for in the elasticity calculations.

Data and sources

Table 5 shows the base information required for making the elasticity estimations. The first three columns show the amount of (nominal and real) United States exports shipped to United States manufacturing MOFAs. These exports represent the United States "inputs" received by these MOFAs. To be sure, not all goods received by United States MOFAs from the United States are in the nature of "inputs". Some are for "resale without further manufacture" and some are capital equipment. The latter

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[a] Estimates for 1985 were made based on data published by the United States Department of Commerce (1988): table 29, col. 3, table 31, col. 3, table 27, cols. 8 and 10. Estimates for 1989 were made based on data published by the United States Department of Commerce (1991b): col. 3 in tables, 32, 34, and 35.

[b] Industry-by-industry producer prices were readily available only for the developed countries. Hence, for the six developing economies for which these data were unavailable, an unweighted producer price index was used.

account for a very small portion (about 1.7 per cent in 1989[a]) of such exports to manufacturing MOFAs and, hence, are not adjusted for in later calculations. On the other hand, goods exported for resale accounted for some 15 per cent of the total in 1989,[b] but these *should* be included in the analysis because, after all, these goods represent United States content in the products sold abroad by United States MOFAs. The last three columns in table 5 focus on the MOFAs' cost-of-goods-sold data. As can be seen by comparing the last two columns in the table, a big portion of the rise in COGS (in dollars) is due to the *translation* effect of stating foreign costs in "cheaper" 1989 dollars. Conversely, changes in costs due to rising local prices accounted for only a small portion of the rise in nominal COGS sold between 1985 and 1989. All data sources are shown at the bottom of table 5.

[a] United States Department of Commerce (1991), table 71, cols. 1 and 2.

[b] Ibid., cols. 1 and 3.

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